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(54) [Title of the invention] A shielding structure for temperature sensors and the method of shielding

(57) [Abstract]

[Purpose] To provide a shielding structure, and a method of shielding, for temperature sensors for achieving significant improvement in productivity and reliability.

[Constitution] A primary shield 7 is provided for the temperature sensor, by injection moulding of a resin over the thermistor element 1, lead wires 2 and the junctions between the lead wires and the insulated electric wire 3 up to the insulation 3b of the insulated electric wire. A secondary shield 8 is provided, also by injection moulding of resin, over the first shield. Projections 7a are provided on the outer surface of the primary shield 7 for anchoring the mould and to prevent movement of the primary moulded shield at the time of injection moulding of the secondary shield. Both the primary and secondary shields are injection moulded from PPS resin, which facilitates better adhesion between the primary and secondary shields and between the primary shield and the insulation (vinyl) of the electric wire.

[Claims]

[Claim 1] A shielding structure for temperature sensors, wherein a primary shield is provided, by injection moulding of a resin over the thermistor element, its lead wires, and the junctions between the lead wires and the insulated electric wire, up to the insulation of electric wire, and a secondary shield is provided, also by injection moulding of resin, over the primary shield.

[Claim 2] The shielding structure as in Claim 1, wherein the insulated electric wire is a vinyl-insulated electric wire and the primary and secondary shields are made of PPS resin.

[Claim 3] The shielding structure as in Claim 1 or Claim 2, wherein the outer surface of the primary shield has

projections embedded in the secondary shield.

[Claim 4] The method of shielding temperature sensors wherein a primary shield having projections on its outer surface is formed by injection moulding of a resin over the thermistor element, its lead wires, and the junctions between the lead wires and the insulated electric wire, up to the insulation of the electric wire and a secondary shield is formed, also by injection moulding of resin, over the primary shield.

[Claim 5] The shielding method as in Claim 4 wherein, the insulated electric wire is a vinyl-insulated wire and the primary and secondary shields are made of PPS resin.

[Claim 6] The shielding method as in Claim 4 or Claim 5, wherein the projections on the outer surface of the primary shield are tapered towards the outside.

[Detailed description of the invention]

[0001]

[Field of industrial application] The present invention relates to shielding technology for temperature sensors. It provides a shield structure for temperature sensors and the method of shielding such sensors.

[0002]

[Existing technology] Temperature sensors consist of a thermistor element, the main part, and lead wires that extend from the thermistor element and are connected by soldering, etc. to conductors at the end of a 2-core parallel insulated

electrical wire. A shield 4 is provided, as shown in Drawing 2 (left) to protect the sensor unit from impact, water and moisture. An epoxy resin-based composition containing hardeners and fillers is applied over the thermistor element 1, its lead wires 2 and the junctions between the lead wires 2 and the conductor 3a of the insulated electric wire 3, up to the insulated part 3b of the electrical wire 3. It is then dried to create the airtight shield 4. Another known method of forming the shield is shown in Drawing 2 (right). Here, the shield 6 is formed by first sheathing the area from the thermistor element 1 up to the insulated electrical wire 3 with a steel pipe 5 and then filling up the gaps inside the pipe with an epoxy resin composition of the type mentioned above or a filling compound 4' to create the airtight shield 6. The steel pipe 5 provides added mechanical strength in this type of shielding.

[0003]

[Problems to be solved by the new invention] In the conventional shielding structure mentioned above, epoxy resin is used for the shielding. This poses some health-related problems, such as some persons handling the resin in the manufacturing process developing eczema, etc. Besides, there are problems with hygroscopicity and heat resistance. To be more specific, the dipping method (applying and drying) used with the epoxy resin forms a shield with somewhat non-uniform thickness and there is the risk of water or moisture seeping in through the thinly coated parts. On the other hand, the

combined use of the epoxy resin composition and a steel pipe, etc. makes the method unsuitable for mass production, which makes product quality non-uniform.

[0004] The objectives of the present invention are to provide a new shielding structure and method of shielding for temperature sensors, which make it possible to achieve major improvements in productivity and reliability.

[0005]

[Means used to solve the problem] The shielding structure for temperature sensors provided by the present invention consists of a primary shield, formed by injection moulding of a resin, over the thermistor element, its lead wires, and the junctions between the lead wires and the insulated electric wire, up to the end of the insulated part of the electric wire, and a secondary shield, also formed by injection moulding of resin, over the primary shield.

[0006] It is preferable that the insulated electric wire is vinyl-insulated wire normally used for this purpose and the primary and secondary shields are made of PPS resin.

[0007] The primary shield should preferably have projections on its outer surface and the projections embedded in the secondary shield.

[0008] In the method of shielding temperature sensors of the present invention, a primary shield having projections on its outer surface is formed by injection moulding of a resin over the thermistor element, its lead wires, and the junctions between the lead wires and the insulated electric wire, up to

the insulated part of the electric wire, and a secondary shield is formed, also by injection moulding of resin, over the primary shield.

[0009] It is preferable to have projections tapered towards the outside, on the outer surface of the primary shield.

[0010]

[Embodiments] An example of applying the present invention is explained below, with reference to Drawing 1. In Drawing 1, 1 is a thermistor element, which is the main part of the temperature sensor. 2 is the lead wire. 3 is a 2-core parallel insulated electric wire having insulation 3b made of vinyl chloride resin over the conductor 3a. 7 is the primary shield and 8 is the secondary shield.

[0011] The lead wires 2 of the thermistor element 1 is soldered or spot-welded to the conductors 3a at the end of the insulated wire 3 before the resin shields are formed.

[0012] The primary shield 7 is formed by injection moulding of a PPS resin over the thermistor element 1, its lead wires 2, and the junctions between the lead wires 2 and the conductors 3a connected together in the aforesaid manner, up to the insulation 3b of the electric wire. Here, the mould for the primary shield must have an inner diameter that is very close to the outer diameter of the thermistor element 1. While moulding, care must be taken to prevent sideways movement of the thermistor element 1 because of the pressure of moulding. The thermistor element 1, lead wires 2 and electrical wire 3 are integrated in this manner. The primary shield 7 has,

integral-moulded on its outer surface, projections 7a with conical (tapered) or cylindrical longitudinal sections, which will be used as stoppers when moulding the secondary shield 8. The projections 7a should preferably have not more 0.5mm diameter at the outer end because if the outer end is thick, the completed product may have some problems with water and moisture resistance.

[0013] The secondary shield 8 is formed by injection moulding of PPS resin on the outer surface of the aforesaid primary shield 7. The mould used for injection-moulding the secondary shield is fixed with the help of the projections 7a in such a way that these projections fit tightly on the inner surface of the mould and the primary moulded shield does not get displaced to left, right, backwards or forwards during the moulding due to the injection pressure during the moulding of the secondary shield.

[0014] If both the primary shield 7 and the secondary shield 8 are made of PPS resin, as in the above example, adhesion between the contact surfaces of the primary and the secondary shields is better as is the contact between the PPS resin and the vinyl resin insulation 3b of the electrical wire 3, and there is no risk of water or moisture penetrating into the sensor. When the temperature sensor prepared in this example was immersed for 500 hours in warm water (60° C) and the characteristics tested under the submerged condition, no abnormality was found.

[0015] If the temperature sensor does not need to be watertight, and only mechanical strength is required, cheaper resins like ABS resin or polypropylene (PP) resin can be used for injection moulding of the shields.

[0016]

[Mechanism and effect of the new invention] In the newly invented shielding structure for temperature sensors, and the method of shielding described above, there is a primary shield and a secondary shield, both of which are injection-moulded from resin. Therefore, it is suitable for mass production and the product is of uniform quality. Particularly when PPS resin is used for forming the primary and secondary shields, the risk of water or moisture penetrating into the sensor is eliminated and the sensor can be used in a harsh highly humid environment. This is a significant benefit in practical applications of the sensor.

[Brief description of the drawings]

[Drawing 1] A partial longitudinal sectional diagram showing an example of the present invention.

[Drawing 2] Thermistor sensors with conventional shielding. On the left is a partial longitudinal sectional diagram of a sensor where the shield is made with epoxy resin alone. On the right is a partial longitudinal sectional diagram of a sensor where the shield is made with an epoxy resin and a steel pipe.

[Key to symbols]

1	Thermistor element
2	Lead wire
3	Insulated electric wire
3a	Conductor
3b	Insulation
7	Primary shield
7a	Projection
8	Secondary shield